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Metropolitan Airline Traffic: Determinants and Effects on Local Employment Growth

Jan K. Brueckner

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

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Jan K. Brueckner, Associate Professor
Department of Economics

Abstract

This paper presents preliminary empirical evidence regarding the impact of airline service quality on a city's business climate. Specifically, the question of whether the level of airline passenger traffic (a proxy for service quality) affects employment growth in a sample of SMSAs is investigated. The expectation is that good airline service makes an SMSA an attractive site for newly-locating firms as well as stimulating the activities of existing businesses. In addition to exploring the employment impact of airline service, the paper also estimates the parameters of a metropolitan air travel demand relationship.

Metropolitan Airline Traffic: Determinants and Effects on Local Employment Growth

by

Jan K. Brueckner

1. Introduction

One occasionally hears the complaints of small-town government officials or business leaders regarding the quality of local airline service. It is alleged that poor airline service inhibits local employment growth by reducing the attractiveness of the city as a location for new businesses and by impairing the health of some existing firms. For example, recent service cutbacks by Ozark Airlines in the city of Champaign-Urbana, Illinois, have been a subject of widespread local concern. The director of the local Chamber of Commerce worries that the deterioration of airline service may thwart attempts to attract high-technology industry to the area.

The cost of transporting inputs and outputs has long been recognized as a factor in the location choices of firms (see Alonso [1] and Hoover [4]). However, the fact that most production-related freight moves by cheap surface transportation means that the beneficial effect of good airline service (if one exists) must arise for reasons unrelated to classical transport cost theory. A plausible rationale for the popular view does emerge from the notion of agglomeration economies. Such economies result from the fact that agglomeration of economic activity increases face-to-face contact among economic agents, facilitating the flow of information and exchange of ideas that underlies a productive economy. Although the growth of urban centers is thought to feed in part on internal agglomeration

economies (see Hoover and Vernon [5]), a plausible subsidiary hypothesis is that airline traffic between cities may lead to intermetropolitan agglomeration economies given the speed and convenience of air travel in the jet age. In other words, air travel may secure the beneficial effects of face-to-face contact even when the relevant firms or organizations are spatially separated. This point is argued effectively by geographer Allan Pred [7, 8]. Commenting on the location of corporate head offices, Pred states that

> ...there are tremendous savings in time, and hence costs, that accrue from the clustering of organizational head offices and ancillary business services in major metropolitan areas. The time and cost savings available in large urban centers are compounded by the superior air-transport connections those places possess...[C]enters which do not have a wide variety and great number of daily nonstop flights to the leading metropolitan complexes within a given system of cities are not particularly attractive...as headquarters locations...because they do not permit nonlocal personal contacts with other organizational head offices to be carried out...efficiently.[1]

In discussing the success of Boise, Idaho as a corporate headquarters location, Pred makes the following additional observations:

> The functioning of major headquarters office units in Boise has also been made viable by the commercial airline services available to that geographically isolated metropolitan area. Early morning departures and convenient evening returns permit a full business day in the San Francisco-Oakland-San Jose metropolitan complex....Early morning departures are also available to Chicago, and hence New York and other leading metropolitan complexes ....[T]he Boise evidence indicates that lesser metropolitan [areas]...possess the potential to house...divisional headquarters...and research and development units. If Boise's experience is representative, there would have to be enough units to form a concentration, good air travel connections

> would have to be available, and the organizations involved would have to...internalize some business services.[2]

Although the contention that airline service affects a city's business climate is intuitively appealing, it is unsupported by hard empirical evidence. As a result, the important question of whether the quality of airline service indeed affects business activity awaits an answer. One purpose of the present paper is to offer some preliminary empirical evidence bearing on this question. The maintained empirical hypothesis is that the quality of a metropolitan area's airline service at the beginning of a given multi-year period in part determines the growth of metropolitan employment over the period. The hypothesis reflects a belief that newly-locating firms will perceive cities with good air service as attractive sites and that existing firms will prosper as a result of the ease of interaction with other metropolitan areas. Since large metropolitan areas are for the most part well-served by the air travel system, attention will be restricted to small cities, where variation in air service quality is more pronounced.

The quality of a small city's airline service depends both on the frequency of flights and the directness of access to major hub airports. Since construction of a service quality measure embodying these characteristics would be difficult, the empirical model uses instead the level of airline passenger traffic as a proxy for the quality of airline service. Since flight frequency will be roughly proportional to the level of passenger traffic, a high traffic level will indicate that the metropolitan area enjoys frequent service, presumably to one or more major hub airports. Given this relationship, the above growth hypothesis

translates into the proposition that employment growth in a metropolitan area will be higher, other things equal, the higher is the level of airline traffic in the base year of the period in question.

While the hypothesis thus relates employment growth to the base-year airline traffic, it does not explain what determines the volume of traffic to begin with. The other principal goal of the paper is to investigate the contemporaneous determinants of the level of metropolitan airline traffic. The empirical specification is demand-oriented, with airline traffic at a given date presumed to depend on metropolitan characteristics such as population, income, and employment composition. Taken together, the employment growth relationship and the air traffic demand relationship form a recursive simultaneous equation system.

The plan of the paper is as follows. The second section discusses the sample and the general form of the estimating equations. The third section reports the results of estimating the air traffic demand equation. The fourth section reports the results of estimating the employment growth equation. The fifth section presents conclusions.

2. The Sample and the General Form of the Estimating Equations

It will be convenient to begin by discussing the selection of the sample. The unit of observation is the SMSA. A number of criteria determined whether any given SMSA was eligible for inclusion in the sample. First, in order to restrict attention to small SMSAs, only those SMSAs whose airport was listed as a small hub or non-hub in 1970 by the Civil Aeronautics Board [9] were allowed in the sample (medium hubs (e.g. Indianapolis) or large hubs (e.g. Kansas City) were excluded).[3]

The largest SMSA in the resulting sample was Northeast Pennsylvania (Scranton and environs) with a 1970 population of 622,000. The second major criterion for inclusion in the sample was that an SMSA could not be closer than 75 miles to a large or medium hub airport. This restriction was designed to insure that the airline service available to the given SMSA is reasonably well measured by traffic at the local airport (residents of small SMSAs near a large or medium hub airport presumably drive or take a bus to such a facility, so that local airline traffic does not appropriately measure the level of air service enjoyed by the SMSA).[4] Other requirements were that the SMSA had to have a single commercial airport, that the airport was served by at least one airline throughout the period under study (1970-78), and that all needed data was available (some Census data is unavailable for certain SMSAs). Under these criteria, 80 SMSAs were eligible for inclusion in the sample (a list is provided in Appendix 1).[5]

In discussing the estimating equations, it will be useful to indicate first their general form, postponing discussion of all the specific variables used until the regression results are presented in later sections. Let T denote air traffic in a given year in an SMSA, measured in departing airline passengers. Let E denote total base-year employment in the SMSA, let C denote a vector measuring the composition of employment, and let ΔE indicate the change in the level of employment over a period starting in the given base year. Let N and Y denote base-year SMSA population and per capita income respectively. Finally, let P measure the SMSA's proximity to a large or medium hub airport, and let Z1 and Z2 be two additional vectors of SMSA characteristics. As explained in

the introduction, the empirical model consists of two equations, one of which determines the level of base-year airline traffic as a function of SMSA characteristics while the other gives employment growth as a function of base-year traffic and SMSA characteristics. Using the above variable definitions, these equations may be written

$$T = \psi(N,Y,C,P,Z1) + u \tag{1}$$

$$\Delta E = \phi(T,E,C,Z2) + v \tag{2}$$

where u and v are error terms.

Consider the employment growth relationship (2) first. The maintained hypothesis is that, other things equal, a higher level of base-year airline traffic T leads to greater employment growth ΔE by inducing newly-locating firms to set up business in the SMSA and by stimulating the activities of existing firms. As explained in the introduction, a high level of T will mean that an SMSA's air service is characterized by frequent departures (and perhaps a variety of possible destinations), insuring flexibility of scheduling for the business traveler.[6] A higher employment level E will also mean greater employment growth, other things equal, simply because increments to employment in otherwise identical SMSAs will be larger the larger the starting level of employment. The employment composition variable C clearly is an important determinant of ΔE since SMSAs whose employment is weighted in favor of declining industries will, other things equal, experience low (or negative) employment growth. The vector Z2 will include variables such

as labor costs and education levels, which influence firm locations and thus the growth of SMSA employment.

Equation (1) relates the level of airline passenger traffic in the base year to various SMSA characteristics. The expectation is that traffic is an increasing function of SMSA population N and per capita income Y and a decreasing function of proximity P to a large or medium hub airport (even though such an airport must be more 75 miles distant given the construction of the sample, some traffic loss to relatively close major hubs no doubt occurs). In addition, the composition of employment C in an SMSA should affect airline traffic. Indeed, if the main premise of this study (that airline traffic affects business activity) is valid, certain types of businesses should be active users of the air transport system and this should be reflected in the traffic demand relationship. Although it is also a determinant of T, the level of total SMSA employment E is not included explicitly in (1) since it is highly correlated with population. Finally, certain other SMSA characteristics captured in Z1 (these are discussed below) should affect traffic.

Two issues related to equation (1) require discussion. First, even though (1) has been referred to as a demand relationship, an important determinant of demand, namely price, has been omitted. Clearly, a high cost of flying from a given small SMSA to a large or medium hub airport where connecting flights to eventual destinations are available will reduce demand, other things equal, as passengers substitute other transport modes or simply restrict travel. Omission of a price variable from the demand relationship is due to the aggregate nature of the traffic data, which prevents isolation of a single relevant price. In this context, it

should be noted that a number of earlier papers take a disaggregated approach to air travel demand estimation, focusing on individual city-pair routes where measurement of price involves no ambiguity (see, for example, Verleger [14], Ippolito [6] and Anderson and Kraus [23]). While such an approach permits reliable estimation of price and income elasticities, the aggregate approach of the present paper appears superior for uncovering the effects on air travel demand of employment composition, metropolitan population size, and the proximity of a large airport. The reliability of the results will be impaired, of course, if the omitted price variable (a synthetic measure of the cost of access to major hub airports) is substantially correlated with any of the right-hand variables in the aggregate demand relationship.

The second issue related to (1) concerns the regulation of airline service by the Civil Aeronautics Board. The fact that entry into airline markets was controlled in the sample period raises the question of whether observed traffic levels reflect demand. This issue seems less urgent, however, when it is realized that airlines were relatively free to adjust flight frequency, so that (assuming the regulated price covered costs) unmet demand would not have been observed.

With the discussion of the general form of the estimating equations complete, the issue of simultaneity can be considered. First, recalling that the effect of the base year employment level E on airline traffic was embodied in the population variable N, it is clear that the system (1)-(2) implicitly shows T as a function of E and gives ΔE, or $E^* - E$ (E^* is terminal employment), as a function of T and E. While the system (1)-(2) is thus formally simultaneous in the variables T, E, and E^*, it

has a recursive structure (E determines T, then E and T together determine E*). As a result, OLS estimators will be unbiased and efficient.

It is important to note that a recursive system is entirely appropriate given the probable lag with which airline service affects employment. A system which is truly simultaneous in employment and airline traffic would fail to capture this lagged response. Also, since employment responds to the level of service, a variable measuring the change in airline traffic has no place in the empirical model.

3. The Demand Equation

This section reports the results of estimating the demand equation (1) for the year 1970. In the regressions, airline passenger traffic is measured by 1970 passenger originations from scheduled service of certificated route air carriers, a category which excludes commuter airlines (Civil Aeronautics Board [9]). An origination is one passenger boarding an aircraft at the point of initial enplanement. This variable is denoted ORIG. The C.A.B. also reports passenger enplanements, but since this variable includes passengers changing planes as well as initial enplanements, it is an inappropriate measure of an SMSA's airline traffic.[7] Population and income are represented by 1970 SMSA population and per capita income. In the empirical work, these variables are denoted POP and INC respectively.

The SMSA's proximity to a medium or large hub airport was represented in different equation specifications by various proximity measures constructed from dummy variables. The first of these dummies, PDA, assumes the value one if a large or medium hub airport is within 100

miles of the SMSA and zero otherwise (recall that all such airports are at least 75 miles distant from the sample SMSAs). PDB assumes the value one if a large hub airport is within 150 miles of the SMSA and zero otherwise. PDC assumes the value one if a large hub airport is within 100 miles of the SMSA and zero otherwise. Since the proximity of a major airport will reduce traffic more in a large SMSA than in a small one (the absolute volume of surface travel to the major airport will be larger in the former case), use of the raw dummies in the demand equation is not strictly appropriate. Accordingly, interaction dummies were computed by multiplying the raw dummies by SMSA population (the resulting variables are denoted PDAINT, PDBINT, and PDCINT). This modification means that the reduction of traffic due to presence of a nearby major airport can vary with SMSA population. Three different equation specifications used different subsets of the available dummies. PDAINT appeared by itself in one specification, PDBINT appeared by itself in another, and PDAINT and PDCINT appeared together in a third. Note finally that the use of dummy variables to capture proximity effects seems appropriate given the probable discontinuous nature of such effects. While an air traveller might drive 100 miles to a major airport, it is doubtful that he would drive 250 or more miles to such a facility. Thus, a discontinuous formulation such as that implied by use of a dummy variable appears appropriate.

The composition of SMSA employment was at first represented by three variables measuring the percentages of 1970 employment in white collar, manufacturing, and government jobs respectively (note that these categories are not all mutually exclusive). For a reason not readily apparent, the

inclusion of the government employment percentage made the coefficient of income in the demand equation statistically insignificant. Consequently, the government employment variable was deleted and replaced by the dummy variable CAP, which assumed the value one if the SMSA was a state capital and zero otherwise. Use of this dummy variable will capture the effect of state government employment on airline traffic but will leave the effect of federal employment unmeasured. The remaining manufacturing and white collar employment variables are denoted MFG and WC respectively.

Finally, the fact that military bases generate commercial airline traffic suggested controlling in the demand equation for the presence of a base. Accordingly, the dummy variable BASE, which assumed the value one if a military base was near or within the SMSA and zero otherwise, was included in the equations.

Variable definitions, sources, and units of measurement are listed in Appendix 2.

Since the regression results were sensitive to the functional form of the equation and since no a priori reason exists to prefer one functional form over another, the non-linear estimation procedure of Box and Cox [3], which allows the functional form to be endogenous, was invoked. Under this procedure, each varible X of the equation is replaced by the new variable $(X^{\lambda} - 1)/\lambda$ and OLS regressions are computed as λ is varied over a range of values in a search for the likelihood maximum. Linear and log-linear equations correspond to $\lambda = 1$ and $\lambda = 0$ respectively, and computation of an asymptotic confidence interval for λ tells whether either (or both) of these common specifications is consistent with the data. It should be pointed out that while the variables

Table 1

Demand Equation--Maximum Likelihood Estimates[†]

Constant	POP	INC	MFG	WC	CAP	BASE	PDAINT	PDBINT	PDCINT	λ	R^2
-3.42 E+01 (6.74)*	7.93 E-01 (9.52)*	6.39 E-01 (1.70)**	2.92 E-01 (1.19)	4.43 E+00 (4.11)*	6.85 E-02 (0.14)	5.85 E-01 (1.90)**	-6.00 E-02 (-2.97)*	---	---	.16	.7231
-3.04 E+01 (-5.41)*	9.22 E-01 (9.84)*	7.50 E-01 (1.91)**	7.57 E-02 (0.37)	3.95 E+00 (4.19)*	-2.69 E-01 (-0.75)	4.47 E-01 (1.93)**	---	-5.97 E-02 (-3.25)*	---	.12	.7297
-4.17 E+01 (-5.36)*	8.34 E-01 (10.27)*	7.81 E-01 (2.22)*	1.30 E-01 (0.45)	4.41 E+00 (3.71)*	1.46 E-01 (0.23)	8.25 E-01 (2.11)*	-3.37 E-02 (-1.37)	---	-7.76 E-02 (-2.61)*	.20	.7474

[†] t-ratios in parentheses

*,** - coefficient significantly different from zero in a two-tailed test at 5% and 10% levels respectively.

ORIG, POP, INC, MFG, and WC are transformed as indicated, the dummies CAP and BASE are untransformed. In addition, the above description of the interaction dummies, which is appropriate for a linear equation, must be modified. Instead of multiplying the raw dummies by population, each raw dummy is multiplied by the transformed population variable to create the corresponding interaction dummy.

Table 1 presents the maximum likelihood estimation results using the three different sets of interaction dummies (the optimal values of λ are shown). In each equation, the population coefficient is positive and strongly significant, indicating as expected that airline traffic is an increasing function of SMSA population. In addition, the income coefficients are positive and significant, indicating that air travel is a normal good, an unsurprising but nevertheless welcome implication (note, however, that the level of significance is only 10% in two cases). The coefficients of the BASE dummy are also positive and significant, indicating that the presence of a military base increases airline traffic. The coefficients of MFG, while positive, are far from being significant, yielding the interesting implication that manufacturing establishments do not generate airline traffic. By contrast, the coefficients of WC are positive and strongly significant, indicating that white-collar-oriented business activity does generate airline traffic. These contrasting conclusions echo the discussion in the introduction, which suggested that the need for face-to-face interaction at distant locations, which is important in many white-collar jobs but would seem to be inessential for the vast majority of manufacturing employees, is responsible for most business air travel. The coefficients of the CAP dummy are erratic

Table 2

Demand Equation--Log-Linear Estimates[†]

Constant	POP	INC	MFG	WC	CAP	BASE	PDAINT	PDBINT	PDCINT	R^2
-1.18 E+01 (-5.04)*	8.85 E-01 (9.38)*	8.97 E-01 (1.94)**	1.46 E-01 (1.11)	2.76 E+00 (4.09)*	-1.64 E-02 (-0.10)	1.89 E-01 (1.83)**	-3.80 E-02 (-2.81)*	---	---	.7219
-1.92 E+01 (-5.39)*	9.97 E-01 (9.82)*	9.59 E-01 (2.09)*	4.40 E-02 (0.34)	2.77 E+00 (4.19)*	-1.39 E-01 (-0.88)	1.94 E-01 (1.91)**	---	-4.28 E-02 (-3.21)*	---	.7300
-1.91 E+01 (-5.46)*	9.51 E-01 (9.97)*	1.13 E+00 (2.47)*	5.34 E-02 (0.40)	2.46 E+00 (3.70)*	-9.85 E-03 (-0.06)	2.03 E-01 (2.02)*	-2.04 E-02 (-1.36)	---	-4.50 E-02 (-2.42)*	.7430

[†] t-ratios in parentheses

*,** - coefficient significantly different from zero in a two-tailed test at 5% and 10% levels respectively.

in sign and never significant, indicating that state government activity does not generate airline traffic. This is not terribly surprising in that much official state government travel (at least in small and medium-size states) may occur by car.[8]

The proximity variables uniformly indicate that the nearby presence of a major airport reduces SMSA airline traffic. In the first equation, the coefficient of PDAINT is negative and significant, showing the depressing effect on local traffic of the presence of a medium or large hub airport within 100 miles of the SMSA. The negative and significant coefficient of PDBINT in the second equation similarly shows that the presence of a large hub airport with 150 miles reduces SMSA traffic. The third equation allows independent measurement of the effects of medium and large airports. The fact that PDAINT's coefficient is insignificant indicates that the presence of a medium hub airport within 100 miles does not reduce local traffic. To test whether the presence of a large airport within 100 miles reduces traffic on the basis of the third equation, a significance test on the sum of the coefficients of PDAINT and PDCINT is called for. The appropriate t-ratio equals -4.08, indicating a significant reduction in local traffic from the presence of a large hub airport. Thus, while a nearby large hub airport reduces local airline traffic, a nearby medium hub airport apparently does not.[9]

Since the variables in the estimated equations have undergone a power transformation (the estimated λ's show that the optimal powers lie between .1 and .2), interpretation of the magnitudes of the estimated coefficients is difficult. However, since the 95% confidence intervals for λ in all three equations cover $\lambda = 0$, it is interesting to consider

the associated log-linear regressions, for which the coefficients are simply elasticities (since $\lambda = 1$ lies outside the confidence interval in each case, the linear specification may be rejected). Table 2 shows the estimated coefficients for the three log-linear equations. The signs and significance levels of the coefficients are unchanged, with the exception of the improvement of the INC coefficient's significance level in the second equation. Although interpreting the coefficient magnitudes for the MFG, WC, CAP, and BASE variables is awkward, the coefficients of POP and INC give the elasticities of airline traffic with respect to population and per capita income. The population elasticities range from .88 to just below 1.00, suggesting that airline traffic increases just less than proportionally with SMSA population. The income elasticities range from .90 to 1.13, suggesting that a roughly constant fraction of income is spent on air travel. This conclusion seems somewhat suspect in that air travel would appear to be a luxury good, with an income elasticity substantially above unity. In fact, the income elasticity estimates are quite sensitive to major changes in the specification of the demand equation. For example, deletion of MFG, WC, and CAP in the third equation raises the income elasticity estimate to 2.11, a number which is close to the elasticity of 2.35 estimated by Ippolito [6]. Thus, although the empirical results undoubtedly establish that air travel is a normal good, they offer less conclusive evidence about its luxury status.

It is interesting to note that the above results on the population elasticities apply only when a major airport is not nearby. The presence of a major airport in fact reduces the population elasticity by the magnitude

of the appropriate proximity dummy coefficient(s). For example, from the third equation, the nearby presence of a medium hub airport would have no effect on the population elasticity while the nearby presence of large hub airport would reduce the population elasticity from .9510 to .8856 (= .951 - .0204 - .0450).

4. The Employment Growth Equation

This section reports the results of estimating the employment growth equation (2) using three different growth periods: 1970-76, 1972-77, and 1972-78. For the first of these periods, Social Security nonagricultural employment data (excluding government workers) was used, while the regressions for the two later periods relied on Bureau of Labor Statistics nonagricultural employment data. It should be noted that while the two later periods straddle the 1974 recession, with 1972, 1977, and 1978 each representing years of expansion, the 1970-1976 period includes two recessions (1970 and 1974), with 1970 being a year of contraction and 1976 a year of expansion (see U.S. Department of Commerce [10]). As explained in section 2, the employment growth equation relates SMSA employment growth over each period to employment in the period's base year and other variables. The employment variables are denoted EMP70, EMP76, EMP72, EMP77, and EMP78.

Since the employment data was not available for all SMSAs, the entire 80-observation sample could not be used for estimating the growth equations. Deletions due to inadequate data, together with several deletions of SMSAs experiencing negative employment growth (the Box-Cox estimation technique cannot handle negative variable values), reduced the sample

size to 75 for the 1970-1976 period and to 59 for the two later periods. Deletions are indicated in Appendix 1.

On the belief that a single-year airline traffic figure might be unrepresentative of typical traffic levels for some SMSAs, a multi-year traffic average was computed for use in the employment growth regressions. Unfortunately, Civil Aeronautics Board publications after 1970 report only enplanements, not originations, so a roundabout method for computing an average traffic figure was employed (recall that enplanements are suspect as a measure of local traffic). The procedure involved multiplying enplanements in 1971 and 1972 for each SMSA by the ratio of originations to enplanements in 1970 to estimate originations in the later years.[10] A three-year average of these estimates and actual 1970 originations was computed and denoted ORIGAV.[11]

The 1970 variables MFG, WC, and GOVT (defined in section 3) represented base year employment composition in the growth equations.[12] Four additional variables designed to measure the attractiveness of the SMSA as a location for new businesses were also introduced. These are 1970 per capita income (INC), the percentage of the 1970 population over 25 years of age having completed at least twelve years of school (EDUC), the percentage of the 1970 population at least 65 years of age (OLD), and a dummy variable (SUN), which assumed the value one for a sunbelt SMSA and zero otherwise. Since an SMSA with low wages, a young and educated labor force, and a sunbelt location would appear to be an attractive site for a new firm, the variables EDUC and SUN were expected to have positive impacts on employment growth, while negative impacts were expected for INC and OLD.

Table 3

Employment Growth Equation--Maximum Likelihood Estimates[1]

Dependent Variable	Constant	ORIGAV	EMP70	EMP72	MFG	WC	GOVT	SUN	INC	EDUC	OLD	PDAINT2	λ	R^2	OBS
EMP76-EMP70	-2.54 E-01 (-0.01)	1.48 E-01 (1.87)**	4.29 E-01 (3.48)*	---	-5.18 E-01 (-2.21)*	2.56 E-01 (0.25)	-4.23 E-01 (-1.30)	1.14 E+00 (2.52)*	-3.56 E-01 (-0.95)	1.36 E+00 (1.94)**	4.57 E-01 (0.90)	1.28 E-02 (0.56)	.23	.6395	75
EMP77-EMP72	1.80 E+01 (0.97)	3.45 E-02 (0.55)	---	5.01 E-01 (5.43)*	-1.00 E+00 (-2.54)*	7.15 E-01 (0.43)	-1.18 E+00 (-1.91)**	1.68 E+00 (1.17)	-4.47 E-01 (-1.93)**	1.39 E+00 (1.53)	5.56 E-02 (0.05)	-2.08 E-02 (-0.88)	.41	.6889	59
EMP78-EMP72	1.73 E+01 (1.24)	7.20 E-02 (0.95)	---	6.17 E-01 (5.70)*	-8.36 E-01 (-2.48)*	9.51 E-02 (0.06)	-9.08 E-01 (-1.75)**	1.10 E+00 (1.18)	-6.46 E-01 (-2.06)*	1.53 E+00 (1.82)**	7.31 E-02 (0.09)	-6.68 E-03 (-0.28)	.32	.7194	59

[1] t-ratios in parentheses

*,** - coefficient significantly different from zero in a two-tailed test at the 5% and 10% levels, respectively.

To test the hypothesis that SMSAs close to large urban centers have different growth experiences than those farther from big cities, an interaction dummy PDAINT2 was included as a determinant of employment growth. The definition of this variable is analogous to that of PDAINT, except that base-year employment replaces population. Note that the structure of the variable allows the effect of proximity to a large city to vary with the given SMSA's base-year employment level.

As in the case of the demand equation, the Box-Cox method was invoked to estimate the growth relationship. Table 3 presents the maximum likelihood estimates. The positivity and strong significance of the base-year employment coefficient in each equation indicates that, as predicted in section 2, absolute employment growth is larger (other things equal) the larger the starting level of employment. The manufacturing percentage coefficients show a similar consistency, with their significant negative signs indicating that SMSAs with base-year employment weighted in favor of manufacturing experienced low employment growth. This finding is consistent with the widely-perceived trend toward employment stagnation in well-established industrial cities. A high initial white-collar employment percentage evidently had no effect on employment growth (no WC coefficients are significant), while a high base-year government employment percentage apparently depressed employment growth (note, however, that one GOVT coefficient is insignificant, while the remaining two are significant at only the 10% level). This latter finding perhaps again reflects the lack of dynamism of old, established urban centers, which no doubt exhibit high concentrations of federal workers.

The performance of the SMSA attractiveness variables largely confirms expectations. The coefficients of INC are negative and two are significant, no doubt reflecting the ability of SMSAs with low wages to attract new businesses. The coefficients of EDUC are positive and two again are significant, suggesting that an educated labor force also attracts newly-locating firms. While the coefficients of SUN are positive, only one is significant, providing mixed evidence for the attractiveness (other things equal) of sunbelt locations. The coefficients of OLD are positive, contrary to expectation, but their very low t-ratios indicate the absence of an effect of an aged population on employment growth. The PDAINT2 coefficients are erratic in sign and insignificant, indicating that the close proximity of a large city has no effect on employment growth in a given SMSA.

With the effects of the above variables in focus, it is possible to turn to the main question of interest: the impact of airline traffic on local employment growth. Recall that the maintained hypothesis is that a high level of traffic generates growth by attracting new businesses to an SMSA and stimulating the activities of existing firms. As can be seen from Table 3, the evidence for such an effect in the sample is mixed. While the coefficient of ORIGAV is positive as expected in each equation, only one coefficient is significant (the confidence level in addition is only 10%). Thus, although the predicted positive effect of airline traffic on employment growth shows up over the 1970-76 period, the effect is not appreciably different from zero over the 1972-77 and 1972-78 periods. It is interesting to note, however, that a slight change in the specification of the growth equation yields more encouraging

results. If the base-year employment variables are replaced by 1970 SMSA population (POP), then the t-ratios of ORIGAV in the three equations rise to 2.08, 1.38, and 1.92 respectively, implying significantly positive impacts of airline traffic on growth over the 1970-76 and 1972-78 periods (the significance levels are 5% and 10% respectively). The new specification does, however, reduce the significance levels of the coefficients of MFG, INC, and EDUC somewhat.

The above empirical results suggest a number of observations. First, the evidence is sufficiently mixed that clear confirmation of the hypothesis of a positive effect of airline traffic on employment growth does not emerge. On the other hand, the existence of several significant ORIGAV coefficients under the different specifications suggests that abandonment of the hypothesis would be premature. Indeed, the main implication of the results is that further empirical research is needed. Ideally, a regression relating employment growth for "interaction-intensive" businesses (those benefitting most from the ease of face-to-face contact afforded by good airline service) to air traffic and other variables would be the best way to test the hypothesis. However, identification of the appropriate type of employment as well as data availability might pose problems. In any case, additional work might provide more clear cut evidence in favor of the hypothesis than that emerging from the present sample.

As a final point, it should be noted that the 95% confidence intervals for λ in the three equations of Table 3 always exclude the values of zero and one. Therefore, consideration of linear or log-linear specifications of the growth equations would be inappropriate.

5. Conclusion

The main findings of this study are as follows. First, the level of SMSA airline passenger traffic is an increasing function of population and income, with the latter result implying (unsurprisingly) that air travel is a normal good. In addition, SMSA airline traffic is higher when a military base is nearby, and traffic increases with the share of SMSA employment in white collar jobs. The latter finding indicates that businesses which stand to benefit most from intermetropolitan interaction (those oriented toward white collar functions) are the most active users of the air transport network. The empirical results also show that the nearby presence of a large hub airport reduces SMSA airline traffic, indicating that travelers use local surface transportation when a large airport is easily reached.

The empirical results also provide some mixed evidence that SMSA employment growth is stimulated by good airline service. The results suggest that employment growth may be higher, other things equal, in SMSAs with high airline traffic levels (and hence good airline service). Holding airline traffic constant, employment growth in the sample was low in established manufacturing cities and high in SMSAs with cheap labor and an educated labor force.

The most important policy implications of the empirical results center on the growth effects of airline traffic. To secure the more vigorous employment growth implied by a higher level of traffic, local governments might attempt to subsidize airline operations by waiving airport user fees and reducing terminal facility rents. This presumably would allow lower local fares (and thus higher traffic) as a result of

reduced airline operating costs. A related point concerns investment in airport facilities. If poor airport facilities prevent the satisfaction of a latent local demand for air travel (for example, gate space may be inadequate), then airport investment may be the best way of generating a traffic increase. Since it is doubtful, however, that such capacity constraints are at all common among small airports, the scope of public policy will typically be limited to reducing local airline operating costs.

Appendix 1

SMSAs in Sample

Abilene, TX*
Albany, GA*
Alexandria, LA*
Amarillo, TX
Appleton-Oshkosh, WI
Asheville, NC*+
Augusta, GA-SC
Austin, TX
Bakersfield, CA
Beaumont-Port Arthur-Orange, TX
Billings, MT
Binghamton, NY-PA+
Boise City, ID
Cedar Rapids, IA
Champaign-Urbana, IL
Charleston-North Charleston, SC
Charleston, WV
Chattanooga, TN-GA
Columbia, SC
Columbus, GA-AL
Corpus Christi, TX
Davenport-Rock Island-Moline, IA-IL
Dubuque, IA
Elmira, NY*+
Erie, PA
Eugene-Springfield, OR
Evansville, IN-KY
Fargo-Moorhead, ND-MN*
Fayetteville-Springdale, AR
Florence, AL*
Ft. Smith, AR-OK
Ft. Wayne, IN
Fresno, CA
Grand Forks, ND-MN*
Grand Rapids, MI
Great Falls, MT
Green Bay, WI
Greenville-Spartanbury, SC
Harrisburg, PA
Huntington-Ashland, WV-KY-OH
Huntsville, AL
Jackson, MS
Johnson City-Kingsport-Bristol, TN-VA*
Knoxville, TN*
La Crosse, WI
Lake Charles, LA
Lansing-East Lansing, MI
Laredo, TX*
Little Rock-North Little Rock, AR
Lubbock, TX
Lynchburg, VA
Macon, GA
Madison, WI
Midland-Odessa, TX*†
Mobile, AL
Monroe, LA
Montgomery, AL
Northeast Pennsylvania, PA*+
Panama City, FL*
Parkersburg-Marietta, WV-OH*
Pensacola, FL
Peoria, IL
Rapid City, SD*
Richland-Kennewick, WA*
Richmond, VA
Roanoke, VA
San Angelo, TX*
Savannah, GA
Shreveport, LA
Sioux City, IA-NE
Sioux Falls, SD
Springfield, IL
Springfield, MO
Tallahassee, FL*
Waterloo-Cedar Falls, IA
Wichita, KA
Wichita Falls, TX+
Williamsport, PA
Wilmington, NC*
Yakima, WA*

*deleted in 1972-77 and 1972-78 growth regressions
+deleted in 1970-76 growth regression
†composite of Midland and Odessa SMSAs

Appendix 2

Variable Definitions, Units of Measurement, and Sources

ORIG - 1970 passenger originations from service of certificated route air carriers, in hundreds of passengers [9]

ORIGAV - average originations 1970-72 (see text for computation) [9]

POP - 1970 SMSA population in hundreds [11]

INC - 1970 SMSA per capita income in dollars [11]

MFG* - percentage of 1970 SMSA employment in manufacturing jobs [12]

WC* - percentage of 1970 SMSA employment in white collar jobs [12]

GOVT* - percentage of 1970 SMSA employment in government jobs [12]

CAP - state capital dummy variable

BASE - military base dummy variable

EMP70, EMP76 - 1970 and 1976 nonagricultural employment, excluding government workers [11]

EMP72, EMP77, EMP78 - 1972, 1977, 1978 nonagricultural employment [13]

SUN - sunbelt dummy variable

EDUC - percentage of 1970 population over 25 years of age having completed 12 or more years of school [11]

OLD - percentage of 1970 population over 65 years of age [11]

PDA - dummy variable which equals one when a medium or large hub airport is within 100 miles of the SMSA and zero otherwise

PDB - dummy variable which equals one when a large hub airport is within 150 miles of the SMSA and zero otherwise

PDC - dummy variable which equals one when a large hub airport is within 100 miles of the SMSA and zero otherwise

PDAINT, PDBINT, PDCINT, PDAINT2 - interaction dummies. PDAINT, for example, equals PDA x $(POP^{\lambda}-1)/\lambda$, with PDBINT and PDCINT defined analogously. PDAINT2 is the same as PDAINT, except that base-year employment replaces POP.

*When the current SMSA is defined differently than the 1970 SMSA (or did not exist in 1970), MFG, WC, and GOVT were computed using 1970 data for the component counties of the current SMSA.

Footnotes

*I wish to thank the Institute of Government and Public Affairs at the University of Illinois for providing financial support during the conduct of this research.

[1]Pred [8], p. 24.

[2]Pred [7], pp. 205-206.

[3]Hub status is determined by enplanements as a percentage of total enplanements in domestic air travel. Large, medium, small, and non-hub airports had, respectively, 1% or more, .25% to .99%, .05% to .24%, and less than .05% of total enplanements (Civil Aeronautics Board [9]).

[4]Non-hub SMSAs within 40 miles of a small hub SMSA were also deleted.

[5]Two SMSAs, Midland and Odessa, Texas, were counted as one observation since they are practically adjacent and share the same airport.

[6]Note that aircraft sizes and load factors must be held constant for a positive relationship between traffic and flight frequency to emerge. These variables will undoubtedly be roughly constant across small airports.

[7]While originations and enplanements were practically identical for the vast majority of sample SMSAs, in several cases (Billings, Boise, Green Bay) enplanements were appreciably above originations.

[8]The coefficient of GOVT in a regression where this variable appeared in place of CAP was significantly negative at the 10% level, indicating that federal government employees in outlying SMSAs are low users of the air travel network.

[9]Note that the coefficient of PDBINT is smaller in absolute value than the sum of the coefficients of PDAINT and PDCINT (.0428 as opposed to .0654). This suggests that a relatively faraway large hub airport (one up to 150 miles distant) reduces local traffic less than a large hub that is closer by (up to 100 miles distant). To make this conclusion rigorous, of course, a regression containing two dummy variables representing different degrees of proximity of a large hub would be required.

[10]While the 1970 and 1971 C.A.B. figures cover the 12 months ending in June of each year, the 1972 figures cover the calendar year. This slight inconsistency resulted from the difficulty of locating the appropriate documents.

[11]Note that use of a three year traffic average instead of actual base year traffic for each period is inconsistent with the model description of section 2. However, it was felt that this procedure might give more reliable results by ironing out short-term traffic fluctuations.

[12]An attempt was made to obtain a disaggregated breakdown of SMSA manufacturing employment from the 1972 Census of Manufacturers, but the spotty coverage resulting from the Census disclosure rules made the data unusable. Also, note that although the 1970-76 employment data exclude government workers, GOVT was included nevertheless as an explanatory variable.

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